Using Soybeans as a Cover Crop on Expired CRP
By Jeremy Wilson

2013 Final Report

Project Number: FNC10-832
Type: Farmer/Rancher Project
Region: North Central
SARE Grant: $6,000.00

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Summary

This study was initiated to encourage the transition to cropland of CRP grassland with no-till to maintain soil health benefits and demonstrate the prior use of cover crops, especially forage soybeans, in improving nitrogen cycling and commodity soybean yields the year following. Eight different treatments, four with and four without forage soybeans were seeded in three randomized replications. The CRP grass was hayed and terminated with herbicides on all treatments. Treatments included just herbicide burndown as a control, 60lbs/acre urea, 60lbs/acre urea plus forage soybeans, forage soybeans as a single species, a cool season mix of multiple species with and without forage soybeans and a warm season mix with and without forage soybeans. ANOVA results indicated individual treatments were not significantly different in yield (P>0.05). Treatments analyzed as groups with and without a forage soybean cover crop showed a significant (P>0.05) difference in soybean yield utilizing a Two-tailed Student's t-test. Yields were 39.9 with and 32.7bu/acre without forage soybeans. This resulted in at least a net return increase of $47.40/acre. Transitioning CRP grassland using no-till and forage soybean cover crops prior to the production soybean year showed positive results on production while maintaining soil health benefits.

About the Producer

I (Jeremy Wilson) and my wife Sarah farm in southeastern North Dakota near Jamestown. My rotation includes soybeans, corn, spring wheat and dry edible beans. I have been a no-till farmer for 12 years. I try to utilize cover crops wherever possible. I have given presentations at many workshops on a range of agricultural subjects.

Figure 1: Forage Soybeans in early September 2011.

Background

Cover crops are used in a variety of situations for a variety of reasons. Some of these include: reduction of fertilizer costs, increased nutrient cycling, reduction of soil compaction, prevention of soil erosion, conserving soil moisture, protecting water quality, potential source of forage for livestock, and enhancing soil health (ref, managing cover crops profitably).

The Conservation Reserve Program (CRP) began with the 1985 Farm Bill. Since that time the acreage enrolled in CRP in Stutsman County expanded and by 2004 had reached 183,342 acres. Recently, due to higher commodity prices and changes in agricultural production in Stutsman County, the amount of enrolled CRP acres has declined to 68,878 acres at the end of 2012. The majority of these acres are being utilized again for crop production (ref, USDA FSA).

The common practice for bringing CRP land back into crop production is utilizing several tillage passes to 'break-up' root masses and to try to smooth the ground. The effects of these tillage practices on the former CRP includes: quick conversion of biomass (which means available nutrient loss), increased compaction at tillage depth, and large potential soil erosion especially on highly erodible land. First year production of a commodity crop on previous Conservation Reserve Program (CRP) grassland has been difficult in North Dakota without very high inputs of fertility and heavy tillage. Soil tests typically show very low inorganic nutrient availability for nitrogen and phosphorus as they are sequestered in unavailable organic forms in the soil and plant biomass. Soybeans are an option since their nitrogen demands are small prior to nodulation by *Rhizobium japonicum*. However, inoculum is not present in the soil since soybean production was introduced to this region after CRP contracts were begun.

Table 1

Plot Type	Species/Fertilizer Type	Rates
Herbicide Only	0	0
Soybeans	Forage Soybeans	40 lbs/ac
Soybeans + Fertilizer	Forage Soybeans	40 lbs/ac
Fertilizer	46-0-0	46 lbs/ac
Warm Seasons with Soybeans	Forage Soybeans	20 lbs/ac
	Chinese Red Cowpeas	4 lbs/ac
	Berseem/Persian Clover	.75 lbs/ac
	Mung Bean	2 lbs/ac
	Oilseed Sunflowers	2 lbs/ac
	Siberian Millet	1 lb/ac
	Sudan or Sorghum-Sudan Hybrid	2 lbs/ac
	Pasja Forage Brassica or Turnip	.25 lbs/ac
Cool Seasons with Soybeans	Forage Soybeans	20 lbs/ac
	Lentil (Rosetown)	8 lbs/ac
	Trapper Spring Peas	10 lbs/ac
	Chickling Vetch (AC Greenfix)	5 lbs/ac
	Sweet Clover (Ylw Blossum)	.5 lb/ac
	Forage Rape	.5 lb/ac
	Pasja Forage Brassica or Turnip	.25 lb/ac
	Radish (Tillage)	.5 lb/ac
Warm Seasons without Soybeans	Chinese Red Cowpeas	10 lbs/ac
	Mung Brean	4 lbs/ac
	Berseem/Persian Clover	.75 lb/ac
	Oilseed Sunflowers	2 lbs/ac
	Siberian Millet	1 lb/ac
	Sudan or Sorghum-Sudan Hybrid	2 lbs/ac
	Pasja Forage Brassica or Turnip	.25 lb/ac
Cool Seasons without Soybeans	Lentil (Rosetown)	12 lbs/ac
	Trapper Spring Peas	18 lbs/ac
	Chickling Vetch (AC Greenfix)	8 lbs/ac
	Red Clover (Medium Red)	1 lb/ac
	Sweet Clover (Ylw Blossum)	1 lb/ac
	Forage Rape	.5 lb/ac
	Pasja Forage Brassica or Turnip	.5 lb/ac
	Radish (Tillage)	.75 lb/ac
	Oilseed Sunflowers	1 lb/ac

In 2009 and 2010, the Stutsman County Soil Conservation District (SCD), the Natural Resources Conservation Service (NRCS), and the North Dakota State University Extension (NDSU Ext.) personnel worked on a demonstration involving expired CRP ground. Cover crop mixes were planted into the CRP ground, where vegetation was removed through haying prior to seeding on August 6, 2009. A concentration was placed on legumes and brassicas, some including soybeans. Soybeans were planted the following year (2010) and yields were found to be 43 bu./ac. to 46 bu./ac. compared to 24 bu./ac. where these mixes were not established. Innoculation of legumes is important, such as soybeans, and is one of the keys to immediate fixing of nitrogen. Establishing a community of rhizobia bacteria for future years is a key for soybeans which will begin to fix nitrogen in early growth stages (Goos and Moran, 1999).

Figure 2: Layout of Areas, Top left is North Area, Below that is South Area, and right is East Area.

Methods

A random block design was developed for this project, which includes three replicated areas. For each treatment a 40 foot wide by 360 foot long strip was plotted (size was determined by equipment capabilities). Location of each area was determined by accessibility and absence of flooded areas. Table 1 shows the 8 treatments and rates used for each.

The plot areas were hayed in July, though some swaths were not baled until just before seeding (and after spraying) in August. The plot was sprayed with glyphosate plus the proper adjuvants on August 2, 2011. The treatments were seeded on August 12, 2011. Soybeans were seeded on May 25, 2012. The entire area was farmed as one field in 2012. Harvest of the soybeans took place on November 1, 2012. Weights of each treatment were measured by combining plot size with moisture and test weight.

Table 2

Sample ID	Date Sampled	Nitrogen 0-24" (lb/ac)	Phosphous (ppm)	Potassium (ppm)
North Area	8/15/2011	31	26	837
South Area	8/15/2011	12	4	356
East Area	8/15/2011	8	6	377
North Area (D)	6/4/2012	58	17	599
North Area (A)	6/4/2012	47	10	491
North Area (E)	6/4/2012	81	31	820
North Area (F)	6/4/2012	67	11	474
North Area (Cc)	6/4/2012	59	14	509
North Area (Bw)	6/4/2012	43	14	444
North Area (Bc)	6/4/2012	35	14	488
North Area (Cw)	6/4/2012	37	9	411
South Area (Cc)	6/4/2012	43	8	386
South Area (A)	6/4/2012	16	7	400
South Area (Bw)	6/4/2012	27	15	420
South Area (Cw)	6/4/2012	12	8	373
South Area (F)	6/4/2012	30	9	373
South Area (E)	6/4/2012	46	6	370
South Area (Bc)	6/4/2012	22	6	354
South Area (D)	6/4/2012	16	4	300
East Area (Cw)	6/4/2012	36	5	318
East Area (A)	6/4/2012	24	4	333
East Area (Bc)	6/4/2012	62	5	398
East Area (Cc)	6/4/2012	57	7	357
East Area (F)	6/4/2012	28	6	337
East Area (E)	6/4/2012	23	5	357
East Area (Bw)	6/4/2012	13	6	329
East Area (D)	6/4/2012	14	6	342

Legend: A is only forage soybeans, Bc is forage soybeans with cool season cover crop mix, Bw is forage soybeans with warm season cover crop mix, Cc is cool season mix without forage soybeans, Cw is warm season mix without forage soybeans, D is herbicide application only, E is forage soybeans with fertilizer, F is fertilizer only.

Soil tests were taken on August 15, 2011 and included one test per replication. Soil tests again were taken on June 4, 2012. Soil test results for nitrogen, phosphorus, and potassium are shown on Table 2. 60 lb/ac. of urea (46-0-0) was applied to the fertilizer treatment areas on August 17, 2011.

Comparing individual treatments was accomplished using ANOVA to determine any statistical difference. To compare the data using soybeans in the seeding mix and those not using soybeans, a two-tailed Student's t-test was used. Data from each replication was combined to provide each data set with 12 entries. The analysis was performed using the Microsoft Excel spreadsheet statistical analysis functions.

Results and Discussion

Cover crop establishment was less than previously experienced in seeding into a CRP grassland. A dry, late summer and fall depleted surface soil moisture and limited germination and growth of cover crops. In addition, an early frost terminated the growth of warm season cover crops 10 days before average frost dates. Despite the climatic limitations cover crops produced above ground biomass between 230 lbs/acre for single species forage soybeans and 2,350 lbs/acre for the cool season mix. Forage soybean roots were identified to have active nodulation. The nodules were observed to be active for at least 10 days after the early frost. This would indicate viable inoculums and a positive response to inoculation in soil that had never had a previous soybean crop.

Difference in the yield of soybeans between the individual treatments was not significant ($P>0.05$) when statistically analyzed using ANOVA. Natural and anthropogenic variability was a limitation in conducting this field plot size study. The original plot location was moved due to above-average rainfall the summer of 2011 which resulted in ponded water at the original location. The site was moved to where one of the replication blocks was near a farmstead and unintentionally placed where historically livestock feeding occurred. This was evident in the fertility analysis of the plots. Composite fall soil samples of the three blocks revealed the north set of treatments with 31lb/acre, 26 ppm, 837 ppm of available nitrogen, Olsen-test phosphorus, and potassium, respectively. This was about 2.5 times the availability in the other two sets of treatments which were more typical of available nutrients in CRP grassland. High N, P and K were again identified in the spring soil sample tests of each individual subplot of the north block in comparison to the other two blocks (Table. 2). Plant Root Simulator™ Western Ag Innovations probes placed in each treatment monitored nutrient availability during the growing season. They indicated a higher cumulative nutrient availability in the subplots closest to the farmstead of the north block when compared to other plots. The higher fertility had a positive influence on yield in the north block but may have interfered with the statistical outcome of the individual treatments of the study.

Treatments analyzed as groups with and without a forage soybean cover crop showed a significant ($P>0.05$) difference in soybean yield utilizing a Two-tailed Student's t-test. Soybean yields following a cover crop with forage soybean in a cover crop mix or as a single species averaged 39.9 bu/acre and when not following a forage soybean, 32.7 bu/acre. Treatments with and without forage soybeans are listed in Table. 1. The four treatments with soybeans all yielded higher than the four treatments without soybeans. Of the treatments with forage soybeans the cool season and warm season cover crop mixes had the top yields with 43.3 and 41.9 bu/acre, respectively. Active nodulation was observed on the forage soybean plant roots. The use of inoculum on the forage soybean plus the additional inoculum produced by actively growing *Rhizobium japonicum* are apparently responsible for the yield increase in subsequent year production soybeans. One other casual

Figure 3: Contrast showing in treatments, August, 2012. Soybeans previous on right and no soybeans previous on left.

observation in the study was that physiological maturity occurred a few days sooner in fertilizer only treatments compared to those where forage soybeans were grown as a cover crop as shown in Figure 3. With a dry, late summer growing season there may have been an influence on nutrient availability, plant vigor, rooting depth and drought resistance.

In this study the cost of establishment of the forage soybean as a single species was $24.00/Acre at a 40# seeding rate. In a mix the seeding rate was 20#/Acre. The no-till seeding operation cost was $15.00/Acre. Using the cost of establishment of the single species forage soybean cover crop and an overall average yield increase of 7.2 bu/Acre for all forage bean treatments, a net return of $47.40/Acre at a soybean price of $12.00/bu was realized.

Conclusions

CRP grassland seeded to an inoculated forage soybean cover crop in the fall prior to the soybean production year can significantly improve yields and net income in no-till conversion to cropland production scenario. The inoculation of a forage soybean cover crop apparently has a positive effect on nodule formation and soybean plant vigor. Transitioning with no-till from tame grassland has been successfully demonstrated in this project. If livestock are a viable option, fall grazing of cover crops could add an additional economic benefit of growing cover crops in the transition year of CRP to crop production. Further study is needed on the nutrient cycling and soil health benefits of other cover crop species seeded into terminated CRP or tame grass prior to no-till conversion to crop production. Also, adding inoculums to less expensive non-soybean cover crops should be studied.

Outreach and Partnerships

In September 2011, Sarah and I conducted a tour, for area producers, of this plot area along with other cover crops they are utilizing on other fields. The tour included Terry Enzminger, another producer who is utilizing grazing on some of my fields, staff from the Stutsman County Soil Conservation District (SCD), the Natural Resources Conservation Service (NRCS), and NDSU Research Extension. Articles in the Stutsman County SCD newsletters have included the intent and design of this project. Future newsletters will include the findings of this project.

Staff from the Stutsman County SCD and NRCS assisted me throughout this project.

References

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